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Figure 3. Conidia more highly magnified.

Figure 4. Section through one side of a cavity containing stylospores. From mazzard cherry.

Figure 5. Stylospores more highly magnified.

Plate IV. Figure 1. Section of choke-cherry stem, showing the mycelium before it has come to the surface, magnified six hundred diameters.

Figure 2. Spermogonia.

Figure 3. Asci and spores of *Sphæria morbosa* from the choke-cherry.

Figure 4. Perithecium with asci.

Figures 5, 6. Ripe ascospores.

Figures 7, 8. Ascospores germinating.

PROFESSOR TYNDALL ON GERMS.

UNDER this head, *Nature* gives an abstract of a paper read by Professor Tyndall before the Royal Society, January 13th, entitled On the Optical Department of the Atmosphere in Reference to the Phenomena of Putrefaction and Infection. Among other things, he wished to free his mind, and if possible the minds of others, from the uncertainty and confusion which now beset the doctrine of "spontaneous generation." Pasteur has pronounced it "a chimera," and expressed the undoubting conviction that, this being the case, it is possible to remove parasitic diseases from the earth. We make a few extracts from this interesting article:—

"To the medical profession, therefore, and through them to humanity at large, this question is one of the last importance. But the state of medical opinion regarding it is not satisfactory. In a recent number of the *British Medical Journal*, and in answer to the question, 'In what way is contagium generated and communicated?' Messrs. Braidwood and Vacher reply that notwithstanding 'an almost incalculable amount of patient labor, the actual results obtained, especially as regards the manner of generation of contagium, have been most disappointing. Observers are even yet at variance whether these minute particles, whose discovery we have just noticed, and other disease germs, are always produced from like bodies previously existing, or whether they do not, under certain favorable conditions, spring into existence *de novo*.' . . .

"The result of the experiments showed that infusions of various substances exposed to the common air of the Royal Institution laboratory, maintained at a temperature of from 60° to 70° Fahr., all fell into putrefaction in the course of from two to four

days. No matter where the infusions were placed, they were infallibly smitten. The number of the tubes containing the infusions was multiplied till it reached six hundred, but not one of them escaped infection.

“In no single instance, on the other hand, did the air, which had been proved moteless by the searching beam, show itself to possess the least power of producing bacterial life or the associated phenomena of putrefaction. The power of developing such life in atmospheric air, and the power of scattering light, are thus proved to be indissolubly united.

“The sole condition necessary to cause these long-dormant infusions to swarm with active life is the access of the floating matter of the air. After having remained for four months as pellucid as distilled water, the opening of the back door of the protecting case, and the consequent admission of the mote-laden air, suffice in three days to render the infusions putrid and full of life. . . .

“From the irregular manner in which the tubes are attacked, we may infer that, as regards *quantity*, the distribution of the germs in the air is not uniform. The singling out, moreover, of one tube of the hundred by the particular *bacteria* that develop a green pigment, shows that, as regards *quality*, the distribution is not uniform. The same absence of uniformity was manifested in the struggle for existence between the *bacteria* and the penicillium. In some tubes the former were triumphant; in other tubes of the same infusion the latter was triumphant. It would seem also as if a want of uniformity as regards *vital vigor* prevailed. With the self-same infusion the motions of the *bacteria* in some tubes were exceedingly languid, while in other tubes the motions resembled a rain of projectiles, being so rapid and violent as to be followed with difficulty by the eye. Reflecting on the whole of this, the author concludes that the germs float through the atmosphere in groups or clouds, with spaces more sparsely filled between them. The touching of a nutritive fluid by a bacterial cloud would naturally have a different effect from the touching of it by the interspace between two clouds. But as, in the case of a mottled sky, the various portions of the landscape are successively visited by shade, so, in the long run, are the various tubes of our tray touched by the bacterial clouds, the final fertilization or infection of them all being the consequence. The author connects these results with the experiments

of Pasteur on the non-continuity of the cause of so-called spontaneous generation, and with other experiments of his own.¹

"On the 9th of November, a second tray, containing one hundred tubes filled with an infusion of mutton, was exposed to the air. On the morning of the 11th, six of the ten nearest the stove had given way to putrefaction. Three of the rows most distant from the stove had yielded, while here and there over the tray particular tubes were singled out and smitten by the infection. Of the whole tray of one hundred tubes, twenty-seven were either muddy or cloudy on the 11th. Thus, doubtless, in a contagious atmosphere are individuals successively struck down. On the 12th, all the tubes had given way, but the differences in their contents were extraordinary. All of them contained *bacteria*, some few, others in swarms. In some tubes they were slow and sickly in their motions, in some apparently dead, while in others they darted about with rampant vigor. These differences are to be referred to changes in the germinal matter, for the same infusion was presented everywhere to the air. Here also we have a picture of what occurs during an epidemic, the difference in number and energy of the bacterial swarms resembling the varying intensity of the disease. It becomes obvious from these experiments that of two individuals of the same population, exposed to a contagious atmosphere, the one may be severely, the other lightly attacked, though the two individuals may be as identical, as regards susceptibility, as two samples of one and the same mutton infusion.

"The author traces still further the parallelism of these actions with the progress of infectious disease. The *Times* of January 17th contained a remarkable letter on Typhoid Fever, signed 'M. D.,' in which occurs the following remarkable statement: 'In one part of it (Edinburgh), congregated together and inhabited by the lowest of the population, there are, according to the corporation return for 1874, no less than 14,319 houses or dwellings — many under one roof, on the "flat" system — in

¹ In hospital practice, the opening of a wound during the passage of a bacterial cloud would have an effect very different from the opening of it in the interspace between two clouds. Certain caprices in the behavior of dressed wounds may possibly be accounted for in this way. Under the heading Nothing new under the Sun, Professor Huxley has just sent me the following remarkable extract: "Uebrigens kann man sich die in der Atmosphäre schwimmenden Thierchen wie Wolken denken, mit denen ganz leere Luftmassen, ja ganze Tage völlig reinen Luftverhältnisse wechseln." (Ehrenberg, Infusions Thierchen, 1838, p. 525.) The coincidence of phrasology is surprising, for I knew nothing of Ehrenberg's conception. My "clouds," however, are but small miniatures of his.

which there are no house connections whatever with the street sewers, and consequently no water-closets. To this day, therefore, all the excrementitious and other refuse of the inhabitants is collected in pails or pans, and remains in their midst generally in a partitioned-off corner of the living-room until the next day, when it is taken down to the streets and emptied into the corporation carts. Drunken and vicious though the population be, herded together like sheep, and with the filth collected and kept for twenty-four hours in their very midst, it is a remarkable fact that typhoid fever and diphtheria are simply unknown in these wretched hovels.'

"This case has its analogue in the following experiment, which is representative of a class. On November 30th a quantity of animal refuse, embracing beef, fish, rabbit, hare, was placed in two large test-tubes opening into a protecting chamber containing six tubes. On December 13th, when the refuse was in a state of noisome putrefaction, infusions of whiting, turnip, beef, and mutton were placed in the other four tubes. They were boiled and abandoned to the action of the foul "sewer gas" emitted by their two putrid companions. On Christmas Day the four infusions were limpid. The end of the pipette was then dipped into one of the putrid tubes, and a quantity of matter comparable in smallness to the pock-lymph held on the point of a lancet was transferred to the turnip. Its clearness was not sensibly affected at the time; but on the 26th it was turbid throughout. On the 27th, a speck from the infected turnip was transferred to the whiting; on the 28th, disease had taken entire possession of the whiting. To the present hour the beef and mutton tubes remain as limpid as distilled water. Just as in the case of the living men and women in Edinburgh, no amount of fetid gas had the power of propagating the plague as long as the organisms which constitute the true contagium did not gain access to the infusions.

"The universal prevalence of the germinal matter of *bacteria* in water has been demonstrated with the utmost evidence by the experiments of Dr. Burdon Sanderson. But the germs in water are in a very different condition, as regards readiness for development, from those in air. In water they are thoroughly wetted and ready, under the proper conditions, to pass rapidly into the finished organism. In air they are more or less desiccated, and require a period of preparation more or less long to bring them up to the starting-point of the water-germs. The rapidity of

development in an infusion, infected by either a speck of liquid containing *bacteria* or a drop of water, is extraordinary. On January 4th a thread of glass almost as fine as a hair was dipped into a cloudy turnip infusion, and the tip only of the glass fibre was introduced into a large test-tube containing an infusion of red mullet. Twelve hours subsequently, the perfectly pellucid liquid was cloudy throughout. A second test-tube containing the same infusion was infected with a single drop of the distilled water furnished by Messrs. Hopkin and Williams; twelve hours also sufficed to cloud the infusion thus treated. Precisely the same experiments were made with herring, with the same result. At this season of the year, several days' exposure to the air are needed to produce so great an effect. On December 31st a strong turnip-infusion was prepared by digesting thin slices in distilled water at a temperature of 120° Fahr. The infusion was divided between four large test-tubes, in one of which it was left unboiled, in another boiled for five minutes, in the two remaining ones boiled and, after cooling, infected with one drop of beef-infusion containing *bacteria*. In twenty-four hours the unboiled tube and the two infected ones were cloudy, the unboiled tube being the most turbid of the three. The infusion here was peculiarly limpid after digestion; for turnip it was quite exceptional, and no amount of searching with the microscope could reveal in it at first the trace of a living bacterium; still germs were there which, suitably nourished, passed in a single day into bacterial swarms without number. Five days have not sufficed to produce an effect approximately equal to this in the boiled tube, which was uninfected, but exposed to the common laboratory air.

“There cannot, moreover, be a doubt that the germs in the air differ widely among themselves as regards *preparedness* for development. Some are fresh, others old; some are dry, others moist. Infected by such germs, the same infusion would require different lengths of time to develop bacterial life. This remark applies to and explains the different degrees of rapidity with which epidemic disease acts upon different people. In some, the hatching period, if it may be called such, is long, in some short, the differences depending upon the different degrees of preparedness of the contagium.”